INTERDISCIPLINARY APPLICATIONS AND INTERPRETATIONS OF ERTS DATA WITHIN THE SUSQUEHANNA RIVER BASIN

Resource Inventory, Land Use, Pollution

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I. PROGRESS ON TASKS

Inventory of Natural Resources and Land Use

In the vegetation study of the Stone Valley area, field notes obtained from the reconnaissance survey made in July have been compared with vegetative signatures and computer-generated maps, resulting in further refinement and delineation of the vegetative types. The LMAP program was used on the CalComp plotter to convert the best computer output into a line map, facilitating interpretation. The LMAP program also permits a choice of scale, so the map was reduced in scale to coincide with the USGS topographic maps (1:24,000). As a result, it was possible to superimpose on this map all road and drainage systems in the study area. A set of random numbers was then generated to locate 40 points for investigation in the field study. These points were located by reference to nearby streams, roads, or powerlines, and field checked. Highly precise location of the points was not required due to the resolution limitations of ERTS imagery. The vegetation at each point was recorded, as well as the vegetation encountered along access routes to each point. Of all 40 points located, only one did not check with the line map. Further progress in classification of this area from ERTS data may be possible when C130 data becomes available for use as ground truth.

Land Use classification of agricultural areas is being studied from several vantage points. In Pennsylvania, work is being conducted in Jefferson County and in Lancaster County.

In Jefferson County, ERTS scene 1244-15305 is being mapped, with mapping categories to date including forest vegetation, bare soil, crops, strip mine spoils, and wet land. An attempt has been made to map "wet land" as defined by the SCS; however, it has not been possible to define a unique signature for this category.

In Lancaster County, ERTS scene 1080-15185, the following categories have been mapped: several forest categories, several water categories, a limestone quarry, bare soil, pasture land, and field with crop residues.

In mapping the above two areas, it has become evident that there are problems in classifying fields. Agricultural fields in much of Pennsylvania tend to be small, irregular in shape, and contoured with narrow strips of two or more crops. It was felt that these characteristics were a major source of difficulty in signature development and classification of agricultural land in Lancaster and Jefferson Counties. In order to be sure that it was indeed these geographical and topographical features which were the source of difficulty and not some problem in the software algorithms, it was decided to map two areas which had large, flat, and regular agricultural fields. The areas chosen were in Texas and Montana,

and the preliminary results appear to confirm that the ORSER programs are operating satisfactorily, and the land characteristics in Pennsylvania are the principal cause of difficulty.

A study of land use mapping of 900 square miles in Hill County, Montana, was completed. Supervised and unsupervised classifiers were used on CCT data from ERTS scene 1052-17452, from September 13, 1972. The following classifications were made: summer fallow (5 signatures), stubble (4 signatures), water (5 signatures), vegetation (1 signature), range and prairie (2 signatures), eroded areas (1 signature), and creeks (1 signature). Copies of the report resulting from this study were sent to the ASCS in Hill County, Montana; to the Statistical Reporting Service of the Department of Agriculture, in Washington, D. C.; and to the Agronomy Department of Montana State University.

An initial analysis of an area in Hidalgo County, Texas (ERTS scene 1146-16323) has been made. Signatures for agronomic crops, bare soils, and water bodies have been established. Work is progressing on signatures for range land and cultivated pasture.

A master's thesis, "Comparison of Laboratory and Multispectral Scanner Derived Spectral Signatures for Mapping Soils," was completed by George May. The MSS data used were flown for Harold Rib of the Federal Highway Administration, by aircraft operated by the Willow Run Lab at the University of Michigan. ORSER programs were used to classify the data and produce a thematic map for three soil types. Soil samples from the area were then collected and a computer program was developed to determine the scan line and element number of these sampling locations. The samples were analyzed on a spectrophotometer and the resultant soil spectral signatures were corrected for atmospheric attenuation and solar radiation at the time the MSS data were collected. The corrected laboratory data were then used to map the three soils, using the same method applied to the MSS data. Comparison of the two maps resulted in the following conclusions:

1. It was possible to accurately assign a scan line and element number from the MSS data to each sampling location.

2. Using 12 channels in each case and critical angles for the laboratory-derived signatures of three times those used for the MSS signatures, it was possible to produce 90% agreement between each of the two signature sets for maps of three soil sites.

3. For both the laboratory-derived and the MSS signatures, it was possible to accurately map a siltstone-derived soil and differentiate it from the other two soils. However, the remaining two soils could not be adequately separated, as they were both shaley in character (one was formed from shale and the other from a shaley limestone).

4. In the cases of both the laboratory and the MSS data, signatures derived from only seven channels (3,4,5,7,9,10, and 11) yielded approximately the same results as those derived from 12 channels.

5. Subdivisions in channels 12 (1.0 to 1.4 μm) and 13 (2.0-216 μm) would enhance the spectral differences of soils and facilitate classification separations.

Geology and Hydrology

An ERTS mosaic of Pennsylvania has been assembled for use in lineament analysis. Some of these lineaments will be compared to the known distribution of ore deposits. The scenes used for this mosaic, all from channel 7, were as follows:

Date	ID	Date	ID
20 Aug 72	1028-15293	7 Sep 72	1046-15301
21 Aug 72	1029-15352	10 Oct 72	1079-15124
21 Aug 72	1029-15354	10 Oct 72	1079-15131
6 Sep 72	1045-15240	11 Oct 72	1080-15183
6 Sep 72	1045-15243	11 Oct 72	1080-15185
7 Sep 72	1046-15295		

The main thrust of work during this period has been in the selection of a geographically well-mapped glaciated area in northwestern Pennsylvania for which there is adequate cloud-free ERTS coverage, aircraft data (U.S. Dept. of Agriculture photographs at a scale of 1:20,000), and suitable topographic maps (7 1/2 min) with a forest overlay. Locally, detailed glacial geologic maps are available, as well as regional maps of all of northwestern Pennsylvania. It is now known to what extent glacial deposits of the same or of different ages can be distinguished using ERTS data and the digital processing techniques developed by ORSER. It is hoped that contrasting materials, such as sand and gravel versus till and clay, can be located, for the former type of deposits have economic potential as an aggregate source and as underground water aquifers.

Environmental Quality

A field survey of the Palmerton area was conducted on August 18th to determine the current severity of vegetative damage. It was observed that significant fumigations had occurred since the July 8th visitation and that damage was evident to broadleaved decidious as well as coniferous species. Sassafras trees displayed an interveinal necrosis and white and red pines exhibited a chlorotic mottle on the current years foliage.

Requested aircraft flights of the Palmerton area were flown on September 11 (NASA Wallops C54, Mission 227-4, Flight lines 2 and 3). Another field survey was therefore made of the area on September 15, 16, and 17 to classify visible damage apparent to the white pine stand under investigation at the time of the aircraft flight. A classification system based upon needle length, retention and necrosis, and the overall color of the trees was utilized to document the condition of the foliage. The results of this classification are to be used to determine if similar severity classes can be determined from the color infrared photos taken on September 11th.

Data Processing and Pattern Recognition

The arrival of the Bausch and Lomb Zoom Transferscope has provided the opportunity to cross-correlate photographs and base maps with maps produced by photo-interpretive procedures and with computer generated thematic maps. The approximate scale of the computer-generated map is 1:24,000. This scale is not uniform, however, because of distortion due to the printer line and element proportions. This distortion is completely overcome by the stretch capability of the transferscope. Because the transferscope has a magnification capability of 1-7X or 2-14X, depending on the lens used, it becomes possible to directly compare ERTS images, at a scale of 1:1,000,000 with computer thematic maps Xerox-reduced to 1:96,000. Studies of this combination, however, are quite limited, due to the limited area coverage of computer output (even when mosaicked) with respect to the ERTS image. We are proceeding, therefore, to study comparisons of ERTS images enlarged to a scale of 1:500,000 and computer output reduced to 1:48,000. This combination seems to be an improvement, but the results are not yet conclusive. Future plans include a study of an area using winter and spring images in the interpretation of water features and soil signatures. Aircraft data, both photographic and in the form of MSS tapes, of a chosen area will also be explored.

A procedure for photographic reduction of 7 by 7 foot computer-generated maps from ERTS data was developed. Both 35 mm slides and photographic prints can be made which preserve the identity of printed characters on the map.

RELATED ACTIVITIES

Research

Dr. Petersen visited the University of Wisconsin, where he discussed using remote sensing for a land use and water quality study of the Great Lakes region. These discussions were held with Dr. Gordon Chesters, Director of the Water Resources Center, and Dr. James Clapp,

Director of the Environmental Monitoring and Data Acquisition Group, both of the University of Wisconsin. It was suggested that Dr. Petersen consider investigating computer processing of ERTS data to delineate land cover types with a view toward relating these cover types to water quality. Dr. Petersen will be spending his sabbatical leave during the next academic year with the Water Resources Center at the University of Wisconsin, concerning himself with methods of applying remote sensing technology to the needs of private, state, and Federal organizations.

Reports

ORSER has completed ORSER-SSEL Technical Report 11-73, "ERTS and Aircraft Multispectral Scanner Digital Data Users Manual," describing in detail all ORSER programs to date with specific card descriptions and instructions for use. Other reports in process describing ORSER data handling and processing procedures are as follows:

STORAGE AND RETRIEVAL OF ERTS AND UNDERFLIGHT IMAGERY

DEVELOPMENT OF THE HYBRID APPROACH TO DATA PROCESSING

CATALOGUES FOR REMOTE SENSING DIGITAL DATA TAPES

PROCESSING OF REMOTE SENSING DATA

CORRECTION OF BANDING IN MSS DIGITAL DATA

ANALOG TO DIGITAL CONVERSION AND PROCESSING OF MSS DATA USING A HYBRID COMPUTER

Several research reports are also in the last stages of completion. These are:

LAND USE MAPPING

COMPARISON OF PREPROCESSING AND CLASSIFICATION TECHNIQUES AS APPLIED TO MULTISPECTRAL SCANNER DATA

SURVEY AND INVENTORY OF FOREST RESOURCES

CANONICAL ANALYSIS APPLIED TO THE INTERPRETATION OF MULTISPECTRAL SCANNER DATA

MAPPING OF ANTHRACITE REFUSE

INVESTIGATION OF VEGETATIVE COVER CONDITIONS

ACID MINE DRAINAGE

AGRICULTURAL LAND USE MAPPING

The essence of most of these reports was covered in various chapters of our Type II Report for June 1, 1972 through May 30, 1973. However, it has appeared desirable to issue these as separate reports for dissemination to interested parties, and in several cases these have been updated from work done since May 30.

Conferences

Dr. Parizek presented a talk, "Prevention of Mine Drainage," to the 45th Annual Conference of the Water Pollution Control Associates of Pennsylvania. The conference was attended by approximately 150 people, such as engineers, public regulatory officials, representatives from the Pennsylvania Department of Environmental Resources and the Environmental Protection Agency, and coal mine operators. Lineament mapping on ERTS and SKYLAB images, and fracture trace mapping on aircraft photography was discussed as a means of locating connector dewatering wells to reduce groundwater leakage to underlying mines. These mappable features on remote sensing images can also be a key to location of zones of potential mine roof instability and blow-out zones, which can result when mines are flooded above stream grade in an attempt to abate acid mine drainage.

The significance of gravity wells and their location at lineament intersections was stressed because these sites should both increase the efficiency of dewatering wells and at the same time increase the efficiency of recharge wells used in the gravity or connector well abatement procedure.

Dr. Parizek also attended the Pennrose Conference on Carbonate Rocks, held in Vail, Colorado, by the Geological Society of America. At this conference he presented a talk, "Hydrology of Carbonate Rocks in Humid Regions," in which he discussed new research on lineaments and fracture traces involving the use of ERTS and Skylab data. This conference was attended by 80 invited people.

Visits to ORSER

Capt. Paul Weitz, USN, graduate of Penn State and Skylab Astronaut, visited ORSER on September 27. He gave a seminar and slide show on Skylab, and answered a host of questions from students and staff.

Dr. Jack Crelling, Research Geologist with Bethlehem Steel Corporation (and a former graduate of Penn State) visited ORSER to discuss methods for obtaining ERTS images suitable for coal exploration work, and possible use of the Bausch and Lomb transferscope in the interpretation of these images.

Dr. Pennypacker hosted representatives from four different countries during September, describing the ORSER program to them and discussing the use of remote sensing techniques in plant pathology studies:

1. From the Netherlands: Dr. J. C. Zadocks, Dean of the Agricultural University in Wageningen.

2. From Israel: Dr. Yigal Cohen, Department of Life Sciences, Bar-Ilan University, Ramat Gan; and Dr. J. Rotem, Volcani Center, Agricultural Research Organization, Bet Dagen.

3. From India: Dr. S. Nagarajan, Department of Botany, University of Delhi. Dr. Nagarajan's interest is in predicting the occurrence of wheat rust in India from remote sensing data.

4. From Germany: Dr. Manfred Mogk, Tropeninstitut, abt. Phyto-pathologie und Entomologie, Justus Liebig - Universitat.

Other Activities

Dr. Gold was on a lecture tour of southern Africa, where he delivered six lectures on "Sputnik to Skylab," which included a review of the ERTS program. He also visited the U.N. geological team working on remote sensing techniques for lineament and fracture trace analyses of Lesotho.

Dr. McMurtry gave a talk to the Harris Township Lions Club of Centre County, Pennsylvania, on "Pictures from Above."

Data Requests, Flights, and Receipts

The following data flights were made during this reporting period:

6 August	Mission 247	C130
13 August	Mission 227-1	C54
11 September	Mission 227-4	C54
10 August	Mission 238	RB57
29-31 August	Mission 238	RB57

The following data were received during this reporting period (other than routine ERTS images and tapes):

Mission 194 (C54) photography
Mission 227-1 (C54) photography